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Addressees:

TEST PLAN FOR HYDROLOGIC FIELD TESTS DURING FY 01

Please find enclosed the subject test plan. This plan has been reviewed and approved by Project Managers from the State of Washington Department of Ecology and the U.S. Environmental Protection Agency.

If you want to discuss this matter further or require additional information, please contact Marvin J. Furman at (509) 373-9630.

Sincerely,

John G. Morse

John G. Morse, Program Manager
Groundwater/Vadose Zone Project

GWVZ:MJF

Enclosure

cc: See page 2

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HANFORD GROUNDWATER MONITORING PROJECT

TEST PLAN FOR HYDROLOGIC FIELD TESTS DURING FY01

November 2000
Revised May 2001

Field Hydrology and Chemistry Group
Pacific Northwest National Laboratory

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John Price, Project Manager, Ecology 5-17-01

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1. Purpose and Description of Tests

This Test Plan documents hydrologic test and analysis activities planned for FY01 by the Hanford Groundwater Monitoring Project, managed by Pacific Northwest National Laboratory (PNNL). The purpose of hydrologic testing is to characterize groundwater flow conditions and determine aquifer hydraulic properties. This information is needed to understand groundwater flow and potential contaminant migration near Resource Conservation and Recovery Act (RCRA) Waste Management Areas (WMA) and to better understand the regional groundwater flow system on a sitewide scale. The data may also support hydrogeologic understanding of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Groundwater Operable Units (OU). These hydraulic property data also provide valuable independent information for verifying properties determined from calibration of groundwater flow and transport models. In addition, hydraulic testing at newly installed monitoring wells verifies that the wells are hydraulically well connected to the aquifer.

1.1 Hydrologic Characterization Tests

Descriptions of the characterization tests that will be utilized for each of the test plan components are provided in this section, followed by a tentative schedule showing date ranges for the various characterization activities. Planned hydrologic testing includes several individual test elements designed for specific characterization information. Individual test elements include:

Slug Testing:	for evaluating well development conditions and to provide preliminary hydraulic property information (e.g., hydraulic conductivity) for design of subsequent hydrologic tests
Tracer-Dilution Test:	for determining the vertical distribution of hydraulic conductivity and/or groundwater flow velocity within the well screen section, and for identifying vertical flow within the well screen section.
Tracer-Pumpback Test:	for tracer removal and characterizing effective porosity, an important hydraulic transport parameter
Pumping Test/Recovery:	conducted in concert with tracer-pumpback test. Analysis of drawdown and recovery data provides quantitative hydraulic characterization property information, e.g., hydraulic conductivity, storativity, specific yield

Fifteen new wells were constructed during 2000/2001 in the 200-West Area of the Hanford Site (Table 1). The RCRA WMA and CERCLA Groundwater OU underlying these wells are also provided in the table.

Slug tests will be conducted at each of these wells by instantaneously lowering the hydraulic head within the well and monitoring the recovery with a pressure transducer installed in the well. At each well, slug tests will be conducted using at least two different stress levels to provide information pertaining to well development and possible presence of

near-well heterogeneities. Slug testing is designed primarily to provide initial estimates of hydraulic properties for the design of subsequent, quantitative hydrologic tests. A detailed description of the design, performance and analysis of slug test characterizations is presented in Butler et al. (1994) and Butler (1997).

Table 1. New Wells and relationship to RCRA Waste Management Areas and CERCLA Groundwater Operable Units

Well Number	Well ID	RCRA WMA	CERCLA OU
299-W11-39	C3117	SST T	200-ZP-1
299-W11-40	C3118	SST T	200-ZP-1
299-W11-41	C3119	SST T	200-ZP-1
299-W11-42	C3242	SST T	200-ZP-1
299-W10-27	C3125	SST TX-TY	200-ZP-1
299-W14-15	C3114	SST TX-TY	200-ZP-1
299-W14-16	C3120	SST TX-TY	200-ZP-1
299-W14-17	C3121	SST TX-TY	200-ZP-1
299-W15-762	C3122	SST TX-TY	200-ZP-1
299-W22-80	C3115	SST S-SX	200-UP-1
299-W22-81	C3123	SST S-SX	200-UP-1
299-W22-82	C3124	SST S-SX	200-UP-1
299-W22-83	C3126	SST S-SX	200-UP-1
299-W23-20	C3112	SST S-SX	200-UP-1
299-W23-21	C3113	SST S-SX	200-UP-1

Detailed hydrologic characterization, including tracer dilution and pump back/constant-rate pumping and recovery tests, will be conducted at up to seven well locations. At least one detailed characterization test will be conducted at each of the RCRA WMA where new wells were installed (i.e. SST S-SX and SST T, and SST TX-TY). Detailed characterization tests may also be performed at existing wells. The wells for detailed hydraulic testing will be selected based on the results of the initial slug tests and characterization needs identified by Project Scientists.

For the tracer-dilution test, a bromide solution of known concentration will be placed within the well-screen section. Initial concentration of the tracer in the water within the borehole will be within the range of 100 to 200 mg/L (Br^-). The decline of tracer concentration (i.e., "dilution") with time within the well screen will be monitored directly using a vertical array of bromide specific-ion electrode probes located at known depth intervals. The probes may be slowly raised or lowered during the dilution test to increase the vertical coverage of tracer measurements. Based on the dilution characteristics observed, the vertical distribution (i.e., heterogeneity) of hydraulic properties and/or flow velocity can be estimated for the formation within the well screen section. The presence of vertical flow within the well screen can also be identified from the probe dilution response pattern. A description of the performance and analysis of tracer-dilution test characterization investigations is provided in Halevy et al. (1966), Hall et al. (1991), and Hall (1993).

A pumpback/constant-rate pumping test will be initiated after the average tracer concentration has decreased (i.e., diluted) to a sufficient level within the well screen (usually a 1 to 2 order of magnitude reduction from the original tracer concentration). The objective of the pumpback test is to "capture" the tracer that has moved from the well to the surrounding aquifer. It is anticipated that pumping will be initiated when the tracer concentration has reached about 1-10 mg/L (Br^-). However, if movement is very slow, the pumpback phase may be initiated at higher residual tracer concentrations. Initial calculations indicate that 1 to 8 days will be required for the dilution phase (i.e., for adequate dilution to occur in the well) at most Hanford test site locations.

Tracer recovery will be monitored by measuring the tracer concentration in water pumped from the well. Initial calculations indicate that the centroid of tracer mass will be recaptured within less than 4 h of pumping at 40 L/min. Water levels will be monitored during the constant-rate pumping test and subsequent recovery period using a pressure transducer installed in the well and a data logger. These data will be used to quantitatively characterize the hydraulic properties of the aquifer surrounding the well test interval. For this purpose, the pumping period may be extended for a time duration longer than required for capturing the centroid of tracer mass/concentration. The time required to obtain representative hydrologic property results will be determined using diagnostic derivative analysis results of the drawdown data obtained from the pumped and nearby observation well locations. A detailed description of the use of derivative analysis techniques is provided in Spane (1993) and Spane and Wurstner (1993).

Following termination of the constant-rate pumping test phase, the recovery of water levels within the pumped well will be monitored. If observation wells are located near enough to the pumped well to be influenced by the pumping test, then drawdown and recovery will also be monitored in the observation wells. The time required for recovery monitoring will be assessed in a manner similar to drawdown data collected during the pumping phase, through the use of diagnostic derivative analysis. For general planning purposes, however, recovery monitoring should be maintained for a period equal to the pumping period and preferably longer.

2. Prerequisites

Scheduling

Construction and development of new wells must be completed prior to hydrologic test activities. Testing activities will be coordinated with sampling activities so sampling schedules are not impacted. The sampling schedule for test wells will be checked prior to removing sampling pumps.

Purgewater Management

Purgewater requirements will be verified prior to removing water from the wells. Table 2 provides the major constituents of concern in groundwater. Purgewater will be managed according to the "Strategy for Handling and Disposing of Purgewater at the Hanford Site,

Washington" (1990 or latest revision), which requires that purgewater in the 200-West Area will be contained. Therefore, purgewater generated during testing will be contained and transported to the Purgewater Storage and Treatment Facility or Effluent Treatment Facility (ETF) using appropriate Bechtel Hanford, Inc (BHI) procedures. The purgewater generated during this hydrologic testing is from CERCLA and RCRA past practice groundwater units. The CERCLA and RCRA treatment trains at ETF have the same treatment process and discharge limits. Therefore, Ecology and EPA have agreed that management of this purgewater through the CERCLA treatment train of ETF allows for simplified disposal of any secondary waste generated.

Table 2. Major Contaminants of Concern in Groundwater

Contaminants	S-SX WMA	T, TX-TY WMA	UP-1 OU	ZP-1 OU
Tritium	X	X	X	X
Technetium-99	X	X	X	X
Iodine-129	X	X	X	X
Uranium	X	X	X	X
Nitrate	X	X	X	X
Chromium	X	X	X	X
Carbon Tetrachloride		X		X
Iron		X		X
Manganese		X		X
Nitrite		X		X
Fluoride		X		X

Waste Management

Solid Wastes resulting from managing purgewater from hydrologic test activities will be considered Investigative Derived Waste (IDW) and will be managed in accordance with the approved Waste Management Plans for 200-ZP-1 and 200-UP-1. These will provide for the proper designation and disposal of the IDW at the Environmental Restoration Disposal Facility.

3. Safety

Overhead equipment is a safety hazard during operations where a drilling rig or pump-setting rig is used to install equipment in the well or run slugging rods or flow meters. Personal protective equipment including hardhat, safety shoes, and safety glasses shall be required when working in the vicinity of a drilling rig or pump-setting rig. Pressurized lines are a potential safety hazard during pumping. Safety glasses shall be required when working near pressurized lines or equipment. Noisy internal combustion engines on generators or other equipment pose a hazard to hearing. Earplugs or sound-suppressing earmuffs shall be worn when working near such equipment.

Contaminants in water extracted from the well pose another potential hazard. Current training in Hazardous Waste Operations (HAZWOPR) is required for personnel working at hazardous waste sites, which includes the new monitoring well sites. Protective clothing appropriate for the level of contamination shall be worn when exposure to contaminants is possible. Coveralls, boots, and gloves shall be worn. If any indication of hazardous levels of contaminants is observed, such as odors or unusual color of fluid, work shall stop until the potential hazard is evaluated and appropriate protective measures are taken. Additional safety requirements are specified in the technical procedures (PNL-MA-567).

In case of injury or accident, the PNNL Standards Based Management System (SBMS) subject area "Injury and Illness" shall be followed. This subject area requires that first aid or medical assistance must be obtained in response to a significant injury or illness that occurs in the workplace. Staff must report all work-related injuries or illnesses to their manager.

If emergency medical assistance is required, call the single point of contact (509) 375-2400 or 911. Report all emergencies to the single point of contact (509) 375-2400. A cellular phone will be on hand with the field personnel.

4. Measuring and Test Equipment

Measuring and test equipment will be calibrated in accordance with the Calibration subject area in the SBMS. Measuring and test equipment required for the tests includes the following:

Pressure transducers – for measuring water levels during slug tests and during the tracer pump-back and recovery tests. These instruments are factory calibrated (category 1). Serial numbers and calibration coefficients shall be recorded in the laboratory record book.

Data logger – for recording data from the pressure transducers and downhole Br probes along with a time and date stamp for each measurement. These instruments are factory calibrated (category 1). Serial numbers shall be recorded in the laboratory record book.

In-situ Br probes – bromide specific-ion electrode probes for measuring the in-situ concentration of Br ion within the well screen. These instruments are user calibrated (category 2). Serial numbers shall be recorded in the laboratory record book.

Surface Br Probe – bromide specific-ion electrode probe for measuring the concentration of Br ion in water removed from the well during the tracer pump-back test. These instruments are user calibrated (category 2). Serial numbers shall be recorded in the laboratory record book.

E-tape – for measuring water levels for correlation with pressure transducer measurements and for measuring water levels in nearby monitoring wells for determination of local hydraulic gradients. These instruments are factory calibrated (category 1). Serial numbers and calibration coefficients shall be recorded in the laboratory record book. When measuring water levels in nearby monitoring wells for determination of local hydraulic gradients, the same e-tape shall be used for all measurements whenever possible.

Additional equipment and requirements are specified in the technical procedures (PNL-MA-567).

5. Pretest Verification

Operation of the in-situ Br probes shall be verified after installation in the well and prior to initiation of the tracer dilution test. If any of the probes are not operating or are giving inconsistent readings, then a decision will be made by the PNNL Project Hydrologist whether to proceed with the test. The problem and the decision shall be recorded in the laboratory record book.

6. Work Instructions

The PNNL Project Hydrologist is responsible for supervising the field tests and coordinating and directing subcontractor activities. The specific work instructions for hydrologic characterization tests are contained in PNNL technical procedures (PNL-MA-567), which provide recommendations for the conduct of these activities. Any deviations from these procedures or standards shall be documented in the laboratory record book.

The instructions for conducting slug tests are documented in procedure AT-6 of PNL-MA-567. Information on the Slug Test Record Form (Figure 1 of Procedure AT-6) may be entered in the laboratory record book instead of using the form. The Aquifer Test Data Sheet (Figure 2 of Procedure AT-6) is not required if water levels are recorded using a transducer and data logger. The time of slug test initiation shall be recorded in the laboratory record book.

Instructions for the tracer dilution test and tracer pumpback test are contained in procedure AT-7. Instructions for the constant discharge test, performed in conjunction with the tracer pump-back test, are contained in procedure AT-5. Information on the Aquifer Test Well Information Form (Figure 1 of Procedure AT-5) may be entered in the laboratory record book instead of using the form. The Aquifer Test Data Sheet (Figure 2 of Procedure AT-5) is not required if water levels are recorded using a transducer and data logger. The times of the start and end of pumping and flow rates measured during the test shall be recorded in the laboratory record book. Barometric pressure data are used in the test analysis to remove the effects of barometric changes on water levels observed in the well. These data may be obtained from the Hanford Meteorological Station (hourly data) or recorded at the test site using an absolute pressure transducer. The barometric pressure measurements shall have a resolution of 0.002 psi or better.

7. Documentation and Reporting

Activities associated with the tests shall be documented in a laboratory record book. If more than one laboratory record book is used, the number and custodian of other applicable laboratory record books shall be recorded. For example, calibration records for the in-situ Br probes may be recorded in a separate laboratory record book. The names and location of any computer data files containing test data shall be recorded in the laboratory record book. A back-up copy of such files will be maintained by the Project Hydrologist.

Results of hydrologic tests conducted under this test plan will be available to the public and formally distributed as part of the annual Hanford Site Groundwater Monitoring report, a groundwater quality assessment topical reports, or as a PNNL technical document (e.g., PNNL-13378, "Results of Detailed Hydrologic Characterization Tests Fiscal Year 1999).

8. Tentative Schedule for FY01 Hydrogeologic Tests

The tentative schedule for field test activities during FY01 is listed below. This schedule may be affected by delays in completion of new wells or other unforeseen conditions.

October – May	Slug tests
May - June	Detailed hydrologic tests

9. References

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Halevy, E., H. Moser, O. Zellhofer, and A. Zuber. 1966. Borehole Dilution Techniques - A Critical Review, in International Atomic Energy Agency, Isotopes in Hydrology, Vienna, Austria

Hall, S.H., S.P. Luttrell, and W.E. Cronin. 1991. A Method for Estimating Effective Porosity and Ground-Water Velocity. Ground Water, Vol. 29, No. 2, pp. 171-174.

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Spane, F.A., Jr. 1993. Selected Hydraulic Test Analysis Techniques for Constant-Rate Discharge Tests. Pacific Northwest Laboratory, PNL-8539, Richland, Washington.

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Project: Yes

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Record Note: None

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